Cold Weather
and
Mountain
Medical Considerations

Reference NWTC Cold Weather or Mountain Operations Manual, C004 & M004

Cold Weather and Mountain Medical Considerations

- Individual Care in a Cold or Mountainous Environment
  - Environmental Factors
  - Heat Loss
  - Body Response to the Cold Weather Environment
  - Individual Factors
  - Food and Water Requirements
  - Personal Hygiene

- Cold Weather Injuries
  - Recognition
  - Symptoms
  - Treatment
  - Prevention

- Altitude Sickness
  - Recognition
  - Symptoms
  - Treatment
  - Prevention

Environmental Factors

Severe, unpredictable weather

Extreme temperatures

Humidity – Wet Cold vs. Dry Cold

Altitude

Wind Chill - The combined cooling effect of ambient temperature and wind velocity on a surface

Wind Chill Chart

AIR TEMPERATURE IN FAHRENHEIT

WIND SPEED	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95

WCT (°F) = 35.74 + 0.6215T - 35.75(V0.16) + 0.4275T(V0.16)
Where T is temperature (°F) and V is wind speed (mph)

WIND SPEED BASED ON MEASURES AT 33 FEET HEIGHT. IF WIND SPEED MEASURED AT GROUND LEVEL, BY 1.5 TO OBTAIN WIND SPEED AT 33 FEET IN HEIGHT AND THEN UTILIZE CHART.

Risk Of Frostbite

WIND SPEED	AIR TEMPERATURE IN FAHRENHEIT											
	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	>2H	>2H	>2H	>2H	31	22	17	14	12	11	9	8
10	>2H	>2H	>2H	28	19	15	12	10	9	7	7	6
15	>2H	>2H	33	20	15	12	9	8	7	6	5	4
20	>2H	>2H	23	16	12	9	8	8	6	5	4	4
25	>2H	42	19	13	10	8	7	6	5	4	4	3
30	>2H	28	16	12	9	7	6	5	4	4	3	3
35	>2H	23	14	10	8	6	5	4	4	3	3	2
40	>2H	20	13	9	7	6	5	4	3	3	2	2
45	>2H	18	12	8	7	5	4	4	3	3	2	2
50	>2H	16	11	8	6	5	4	3	3	2	2	2

GREEN-LITTLE DANGER (frostbite occurs in >2H in dry exposed skin)

YELLOW - INCREASED DANGER (frostbite could occur in 45 minutes or less in dry, exposed skin)

RED- GREAT DANGER (frostbite could occur in 5 minutes or less in dry exposed skin)

Time to occurrence of frostbite in the most susceptible 5% of personnel. Wet skin could significantly decrease the time for frostbite to occur

Windchill Category

Work Intensity	Little Danger	Increased Danger	Great Danger
High Digging foxhole, running, marching with rucksack, making or breaking bivouac	Increased surveillance by small unit leaders; Black gloves optional - mandatory below 0°F (-18°C);	ECWCS or equivalent; Mittens with liners; No facial camouflage; Exposed skin covered and kept dry; Rest in warm, sheltered area; Vapor barrier boots below 0°F (-18°C) Provide warming facilities	Postpone non-essential training; Essential tasks only with <15 minute exposure; Work groups of no less than 2; Cover all exposed skin, Provide warming facilities
Low Walking, marching without rucksack, drill and ceremony	Increased surveillance; Cover exposed flesh when possible; Mittens with liner and no facial camouflage below 10°F (-12°C); Full head cover below 0°F (-18°C). Keep skin dry -especially around nose and mouth.	Restrict Non-essential training; 30-40 minute work cycles with frequent supervisory surveillance for essential tasks. See above.	Cancel Outdoor Training
Sedentary Sentry duty, eating, resting, sleeping, clerical work	See above; Full head cover and no facial camouflage below 10°F (-12°C); Cold-weather boots (VB) below 0°F (-18°C); Shorten duty cycles; Provide warming facilities	Postpone non-essential training; 15-20 minute work cycles for essential tasks; Work groups of no less than 2 personnel; No exposed skin	Cancel Outdoor Training

These guidelines are generalized for worldwide use. Commanders of units with extensive extreme cold-weather training and specialized equipment may opt to use less conservative guidelines.

How does the body lose heat?

Radiation – 60%

Convection – variable

Conduction - variable

Respiration – 6% - 10%

Evaporation - 12% - 15%

Body Response to the Cold Weather Environment

Shell/Core Effect – body pulls blood from extremities in an effort to keep the core warm.

Cold Diuresis – result of the shell/core effect; body rids itself of fluid (increased urination), because the kidneys sense an increase of volume in the core; thirst mechanism is also disrupted

Individual Factors

Age

Geographic Origin

Discipline Factor

Psycho-Social

Training

Fatigue

Experience

Activity

Drugs

Nutrition

Previous Cold Injuries

Other Injuries

Food and Water Requirements

Calories – 4500-6,000 calories per day

Fats and proteins

Hot meals

Vitamins

3.5-5 quarts of water per day

Personal Hygiene

Washing/Shaving
Oral Hygiene
Water Sources
Food Sources
Nicotine and Alcohol
Latrines
Clothing
Sleeping Bags

Dehydration

What is it? Excessive loss of body fluids. In a cold environment, results from the shell/core effect and cold diuresis or overdressing.	**Symptoms:** Headache, Dizziness, Rapid heartbeat, Painful urination Constipation, Lack of appetite, Darkening of urine, Fatigue
Prevention: Drink 3.5-5 quarts of water per day. A way to determine if fluid intake is adequate is to monitor the color of urine – light to straw colored is good; dark brown is trouble.	**Treatment:** Replace lost water. Liquids should be replenished slowly, not in large quantities. In extreme cases medical treatment and IV fluid replacement may be necessary.

Hypothermia

What is it? Excessive heat loss from exposure to a low ambient temperature, wetness, high humidity and wind.	**Symptoms:** In mild cases: uncontrollable shivering, body temperature of 90-96º F and altered mental state (irrational thought patterns); false sense of warmth; personality changes In severe cases: lack of shivering, body temperature below 90º F and a severely altered mental state
Prevention: Apply the COLD principles; proper wear of ECWCS; anticipate the need for warming shelters, change of clothing etc.; adequate hydration and nutrition	**Treatment:** In mild cases, reduce the cold challenge and add heat (change to dry clothing, get into warming shelter, sleeping bag etc.); have the individual exercise; provide food and warm liquids. In severe cases you must evacuate the

Chilblain

What is it? Condition resulting from excessive exposure to cold temperature, marked by inflammatory swelling of hands and feet accompanied by severe itching and burning sensations, and sometimes ulceration; usually affects individuals with a history of cold limbs in summer as well as in winter.	**Symptoms:** Swollen red tissue (in light skinned individuals) or darkening of the skin (in darker skin types). This injury DOES NOT involve freezing of tissue.
Prevention: Proper wear of clothing; proper hydration and nutrition	**Treatment:** Warm affected area with direct body heat; do not massage or rub affected area, do not wet the area or rub it with snow or ice; do not expose affected area to open fire,

Frostbite

What is it? Freezing of body tissue. The ambient temperature MUST be below 32º F in order for frostbite to occur. Superficial (frostnip) – only the outer layer of skin is affected Deep – more tissue involved; can be down to and include bone	**Symptoms:** Superficial frostbite (frostnip) – waxy, white or gray skin (pink or red in dark skinned individuals) pliable underlying layers; Deep frostbite - the tissue is white or bluish and firm to the touch and will not move over underlying layers.
Prevention: Proper wear of clothing; use contact gloves to handle equipment; use approved gloves to handle POL products; keep face and ears covered and dry; avoid tight, restrictive clothing; adequate hydration and nutrition; avoid alcohol and tobacco products	**Treatment:** Superficial - Field treatment is to warm affected area with direct body heat or use water at temp of approx 105º F; once thawed, do not allow tissue to re-freeze; Deep - DO NOT thaw the injury, if thawing occurs do not allow to re-freeze or bear weight; evacuate NEVER moisten or rub with

94

94 & 95 Severe freezing injury with severe hypothermia, in an infant left in the snow in midwinter. The pictures, taken at age five, demonstrate severe soft tissue changes, marked lymphedema and segmental phalangeal amputation. Furthermore, demonstrated in **95** is the complete destruction of the phalangeal epiphysis, as well as complete destruction and dissolution of the carpi bilaterally. Growth plate cartilage is susceptible to cold, resulting in epiphyseal necrosis, digital deformity and shortening of the phalanges.

Color Atlas of Mountain Medicine
Ed. J. Vallotton, F Dubas, Mosby 1991

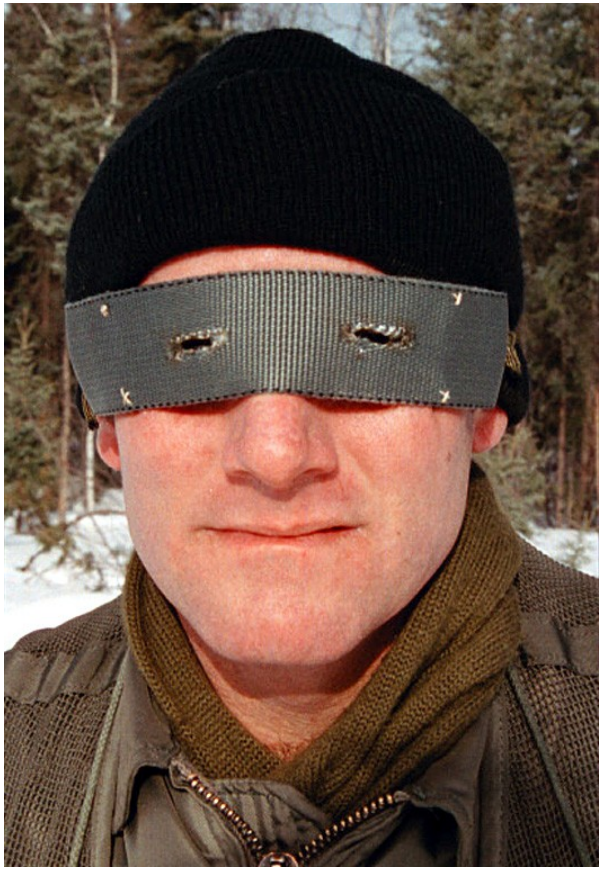
Immersion Foot

What is it? Prolonged exposure to cold wet conditions. Inactivity, damp socks and boots speed onset and severity.	**Symptoms:** Cold, numb feet; may progress to hot with shooting pains; swelling, redness and bleeding in severe cases.
Prevention: Keep feet warm, clean and dry with frequent sock changes; wet socks should be dried out ASAP to allow them to be re-used; wipe VB boots out once per day (minimum); dry boots overnight by stuffing with paper towels	**Treatment:** Re-warm and dry feet by exposing to warm air; do not allow victim to walk on injury; do not rub, moisten or expose area to extreme heat; evacuate

Snow Blindness

What is it? Burning of the cornea of the eye by exposure of the eyes to intense UV rays of the sun in a snow-covered environment.	**Symptoms:** Pain, red eyes, watery or gritty feeling in the eyes.
Prevention: Sunglasses or goggles in a snow covered environment; improvise slit glasses in a survival situation	**Treatment:** Rest and total darkness for 24-36 hours; evacuate if no improvement after this time.

Improvised Slit Glasses



Carbon Monoxide Poisoning

What is it? Replacement of oxygen with carbon monoxide in the blood stream caused by breathing fumes from improperly ventilated heat sources.	**Symptoms:** In mild cases headache, confusion, tiredness, excessive yawning; in severe cases cherry red lips (grey in dark skinned individuals), unconsciousness
Prevention: Use only Army approved heaters in sleeping areas and ensure that all personnel (to include fire guards) are properly licensed on stove; never sleep in running vehicles; always post fire guard when operating heaters in sleeping areas	**Treatment:** Move to fresh air; CPR if needed; evacuation

Altitude Illness: What is it?

- **Adverse affects of altitude on the human body**
- **Altitude Illness comprises ALL the problems associated with not feeling well at altitude**

Altitude Classifications

- **Altitude: 8,000-12,000**
- **High altitude: 12,000-18,000**
- **Extreme altitude: 18,000-29,000**

Reference: ***Medicine for Mountaineering, 5th edition by James A. Wilkerson, M.D.***

- **Low: Sea Level to 5,000 feet**
- **Moderate: 5,000-8,000 feet**
- **High: 8,000-14,000 feet**
- **Very High: 14,000-18,000**
- **Extreme: 18,000 and higher**

Reference: ***FM 3-97.6 Mountain Operations***

Altitude Overview

- **At all altitudes the air is made up of 21% oxygen**
- **As you gain altitude the air pressure drops**
- **Less oxygen is available to the body because of this reduced pressure**
- **Less oxygen available means you suffer the effects of altitude**

Altitude	BarP	PIO2	PaO2	PaCO2	SaO2
0	760	149	94	41	97
5,000	630	122	75-81	39	92
7,500	570		69-74	31-33	92-93
15,000	425	76	48-53	25	86
18,000	379	69	40	29	76
20,000	352	63	37-45	20	71
25,000	291		32-39	13	68
29,000	253	42	26-33	9.5-13.8	58

BarP: barometric pressure
PIO2: pressure of inhaled oxygen
PaO2: arterial oxygen pressure
PaCO2: arterial carbon dioxide pressure
SaO2: percent of arterial oxygen saturation

Initial Physiological Response to Altitude

- ***Increased rate and depth of breathing***
- ***Decreased oxygen saturation***
- ***Changes in pH***
- ***Pulse Rate and Cardiac Output***
- ***Blood Volume***
- ***Sleep Hypoxia***

Acclimatization

- ***Increased Respiratory Volume***
- ***Increased Pulmonary Artery Pressure***
- ***Increased Cardiac Output***
- ***Increased Number of Red Blood Cells***
- ***Changes in Oxygen-Carrying Capacity***
- ***Changes in Body Tissues***

Acute Mountain Sickness

What is it? A collection of non-specific symptoms that can resemble the flu, carbon monoxide poisoning or a hangover. Typically occurs at altitudes above 8,000 feet.	**Symptoms:** Dizziness, shortness of breath, headache, insomnia, upset stomach, depression
Prevention: Maintain a slow ascent rate. Work high and sleep low – altitude increases of greater than 1000’ per day are not recommended; some prescription medications can aid acclimatization; adequate hydration and nutrition	**Treatment:** Slow ascent rate; rest; aspirin or other OTC meds may help; eat and ensure individual is hydrated; Diamox may help

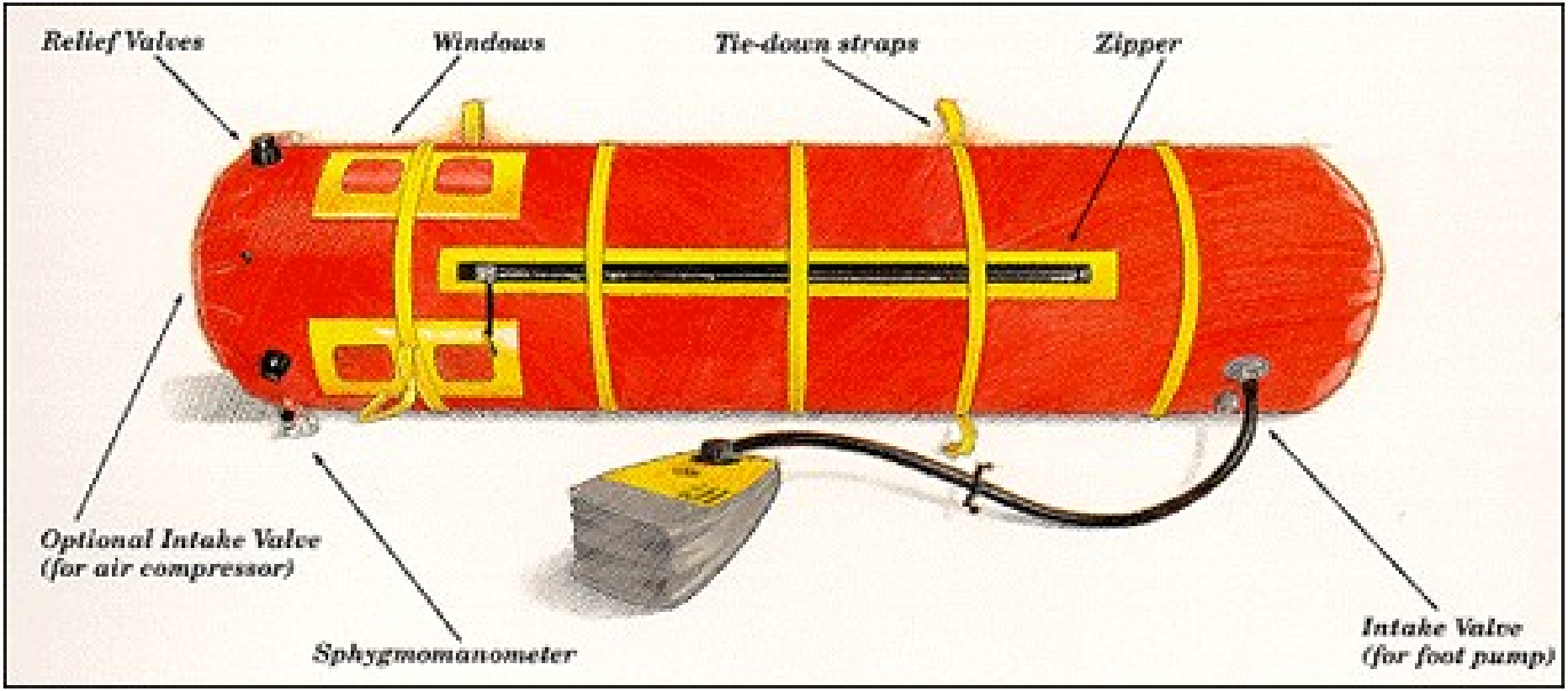
High Altitude Pulmonary Edema

What is it? Lungs fill with fluid (blood serum) that leaks from capillaries. Also known as dry land drowning - as the lungs fill with fluid the individual begins to lose the ability to get oxygen into the bloodstream.	**Symptoms:** In the early stages shortness of breath during exertion and an infrequent cough; as it develops shortness of breath at rest, gurgling respirations (rales), and a frequent cough that produce pink or white frothy sputum; fever; looks similar to pneumonia
Prevention: Maintain a slow ascent rate. Work high and sleep low – altitude increases of greater than 1000’ per day are not recommended; some prescription medications can aid acclimatization; adequate hydration and nutrition	**Treatment:** Rapid descent of 2000-4000’ immediately; oxygen, medications or Gamow bag may temporarily help but rapid descent is the only definitive treatment**;** Diamox helpful in early stages

High Altitude Cerebral Edema

What is it? Increased intracranial pressure (swelling of the brain), caused by fluid leaking from capillary leakage.	**Symptoms:** Headache, nausea, dizziness, loss of appetite, fatigue and insomnia ; in severe cases a severe headache and vomiting
Prevention: Maintain a slow ascent rate. Work high and sleep low – altitude increases of greater than 1000’ per day are not recommended; some prescription medications can aid acclimatization; adequate hydration and nutrition	**Treatment:** Rapid descent of 2000-4000’ immediately; oxygen, medications or Gamow bag may temporarily help but rapid descent is the only definitive treatment**;** Dexamethasone (Decadron) may help with symptoms but is only temporary

Gamow Bag


Relief Valves
Windows
Tie-down straps
Zipper
Optional Intake Valve
(for air compressor)
Sphygmomanometer
Intake Valve
(for foot pump)

Tips for Operations at Altitude

- ***Driving or flying to altitudes above 10,000 feet is not recommended; it will take 24-72 hours to adjust if you do fly to altitudes above 10,000 feet***

- ***Stay properly hydrated…you can lose up to 4 liters per day just breathing…think about water sources, and the resources required to make the water drinkable (filters, stoves, iodine etc.)***

- ***High carbohydrate diets are recommended***

- ***If an individual shows symptoms of altitude illness, you cannot take that person to a higher altitude until the symptoms have subsided; if the symptoms worsen, it is time to evacuate that individual to a lower altitude. Even a wait of a few***

Tips for Operations at Altitude

- ***24-72 hours after arrival at altitude, begin a PT program that will mimic the operations you will be conducting; if possible train at higher altitudes and sleep at lower altitudes***

- ***Diamox can help but may not be appropriate for all individuals***

- ***Tobacco, alcohol, dehydration, depressant drugs and over-exertion will inhibit acclimatization***

- ***Remember that you and your soldiers will never be able to perform to sea level capacity; everything will take longer to accomplish***

Giardia

What is it? A protozoan parasite commonly found in backcountry water sources.	**Symptoms:** Abdominal pain, intense nasuea, intestinal gas, diarrhea, weakness, loss of appetite
Prevention: Treat all suspect water sources by boiling, chemical treatment or filtration.	**Treatment:** Hydration, I.V. fluids, medications, evacuation

Constipation

What is it? Infrequent or difficult passage of stool caused by dehydration, dietary patterns, and ignoring nature's call.	**Symptoms:** Abdominal pain, abdominal rigidity, painful defecation, cramping, loss of appetite, headache
Prevention: Adequate hydration and nutrition; heed nature's call	**Treatment:** Manual removal, clinical spoon, surgery

Heat Exhaustion

What is it? Early volume shock caused by dehydration. The core temperature is generally NOT elevated.	**Symptoms:** Weak, thirsty, and nauseated; vomiting is common; pulse and respiration rates will be higher; temperature is normal or slightly elevated; mildly altered mental status
Prevention: Drink before you become thirsty; keep up with the demands for water (3.5- 5 quarts per day); clothing adjustments; moderate physical exertion in hot climates	**Treatment:** Stop physical exertion; assist evaporative cooling with cool water on the skin; re-hydrate (IV treatment is best); it may take up to twelve hours to bring the individual back to normal

Heat Stroke

What is it? Most severe form of heat illness. Rectal temperature above 104º F.	**Symptoms:** Rapid onset; Collapse; pulse and respiration elevated; skin may be covered in sweat or dry and red; severely altered mental state; unconsciousness; convulsions; dilated pupils that are unresponsive to light
Prevention: Prevention: Drink before you become thirsty; keep up with the demands for water (3.5- 5 quarts per day); clothing adjustments; moderate physical exertion in hot climates	**Treatment:** Evacuate immediately; move to cool area and shade from direct sunlight; soak clothing with water and fan to increase air circulation and evaporation; IV fluid replacement

Hyponatremia

What is it? Also known as water intoxication; it is an excess of water that causes an electrolyte imbalance	**Symptoms:** dizziness; headache; swelling in the hands and feet; nausea, vomiting; altered mental state
Prevention: Monitor water consumption of subordinates; forced hydration of large quantities of water is a causative factor and is not recommended.	**Treatment:** Evacuate immediately; must be evaluated and treated by a physician.

Summary